Finger dexterity predicts early math skills development: Insight from 3D human motion analyses.

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Introduction

Children use their fingers as support for their early numerical skills development (Fayol & Seron, 2005). Then, the fingers are used in order to support the learning of the **verbal number sequence** (Alibali & Dirusso, 1999) and the **counting procedure** (Gelman & Gallistel, 1978). Moreover, they could facilitate the acquisition of the **cardinality** (the association between a number word and the quantity) (Gunderson, Speapen, Gibson & Goldin-Meadow, 20015) and the first **arithmetical skills** (Baroody, 1987).

An increasing number of authors have questioned the functional role of the fingers in young children. It has been shown that **finger gnosia** (Noël, 2005) are good predictors of the children's early arithmetical skills development. Very few studies had questioned the influence of the fine motor skills on the early mathematical skills. If the influence of the **dexterity** on early arithmetical skills has been demonstrated (Asakawa & Sugimura, 2014) the respective contribution of **finger coordination and finger dissociation** (two components of the fine motor skills) to early mathematical skills has never been examined.

Are the finger skills (finger gnosia, finger dissociation and finger coordinaton) good predictors of early mathematical skills development after the age has been taken into account ?

Method

Participants

16 preschoolers (Age = 49.31months ± 7.37)

- First or second Grade in mainstream Belgian schools
- Typical development
- Subset knowers (who have not fully mastered the cardinal principle)

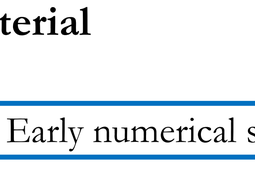
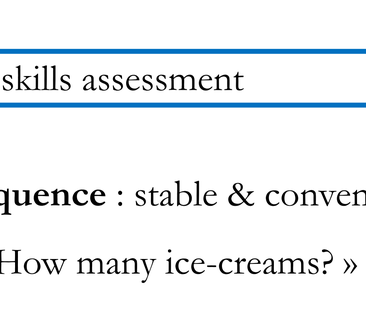
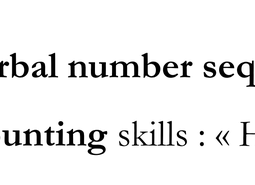
Material

Early numerical skills assessment

- **Verbal number sequence** : stable & conventional part
- **Counting** skills : « How many ice-creams? »
- **Cardinality** : Give-a-number task
  Verbal condition « Give-me three penguins »
  Digital condition « Give-me penguins »
- **Arithmetical** skills: verbal problems supported by pictures

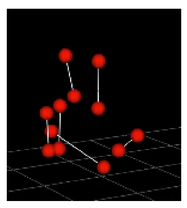
Finger skills assessment

SCAN ME

Fine motor skills assessment

Finger dissociation



« Imitate the gesture that I show you »

Finger coordination


Finger gnosia assessment

« Which finger did I touch ? »

Results

Statistical analyses

Stepwise multiple regression analysis were performed on each numerical task with age, finger gnosia, finger dissociation and finger coordination as predictors.

Verbal number sequence and counting procedures

Model	Coeff.	*t*	*p value*	
Verbal number sequence				
Model 0 • Age	.69	*3.62*	*.003*	*$F(1,14) = 13.12, p<.01, R^2=.48$*
Counting skills				
Model 0 • Age	.43	*1.77*	*.01*	*$F(1,14) = 3.12, p<.01, R^2=.18$*

Give-a-number task with number word

Model	Coeff.	*t*	*p value*	
Model 0 • Age	.52	*2.30*	*.04*	*$F(1,14) = 5.27, p=.04, R^2=.27$*
Model 1 • Age • Gnosia	.68 .49	*3.26* *2.34*	*.006* *.03*	*$F(2,13) = 6.22, p=.01, R^2=.49$*
Model 2 • Age • Gnosia • Coordination	.49 .52 .44	*2.48* *2.85* *2.31*	*.03* *.01* *.04*	*$F(3,12) = 7.30, p<.005, R^2=64$*

Give-a-number task with number gesture

Model	Coeff.	*t*	*p value*	
Model 0 • Age	.62	*2.92*	*.01*	*$F(1,14) = 8.55, p<.01, R^2=.38$*
Model 1 • Age • Gnosia	.77 .49	*4.13* *2.61*	*.01* *.02*	*$F(2,13) = 9.44, p<.01, R^2=.59$*

Arithmetical skills

Model	Coeff.	*t*	*p value*	
Model 0 • Age	.20	*2.56*	*.04*	*$F(1,14) = 6.54, p=.02, R^2=.32$*
Model 1 • Age • Coordination	.35 .48	*1.60* *2.22*	*.006* *.03*	*$F(2,13) = 6.66, p=.01, R^2=.51$*
Model 2 • Age • Coordination • Gnosia	.49 .52 .48	*2.72* *2.97* *2.90*	*.03* *.01* *.04*	*$F(3,12) = 9.78, p=.002, R^2=71$*

Conclusion

Finger skills do not explain a significant part of the variance in the knowledge of the **verbal number sequence** or in the **counting procedures**.

In line with previous studies, after the age has been taken into account, **finger gnosia** was found to be the best significant predictor in the verbal and digital give-a-number task.

Finally, **finger coordination** came out as the best predictor of early arithmetical skills, after the age has been taken into account even if finger gnosia still contribute in the explanation of an additional part of variance.

For future research, we could :
→Increase the sample size
→Work with children with mathematical disabilities